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NOTES AND COMMENTS.

I.

THE GREAT EARTHQUAKE AND THE CHANCES OF FUTURE DESTRUCTIVE EARTHQUAKES IN THE UNITED STATES.

I MUST confess to some surprise at the manner in which the great earthquake, which shook the Eastern half of the American continent, has been dealt with by many throughout the country, who have considered it either in its scientific aspect or as affecting the confidence which the inhabitants of the disturbed region can place in its future stability. On the first point, I have been more struck by what has been advanced as known than by the expression of opinions which appear absolutely unscientific. It has seemed as though the admission of "I do not know," which Lagrange long since said that the true man of science must constantly have to make (if he is honestly outspoken), is one which is not too readily made in these days, or in connection with this particular subject. Yet the public can form but one opinion when so many and such diverse opinions are expressed by those to whom it refers for information; and surely it would be far better if the public concluded that men of science were doubtful on this subject because they frankly admitted as much, than that they should arrive at this conclusion because many men of science claimed to know, but all expressed different opinions.

The broad fact known to all the world is, that over a region where there are no active volcanoes, and where, although there have been earthquakes, none have hitherto been recorded by which serious destruction has been wrought or loss of life occasioned, a series of shocks have taken place, by which many lives have been lost, many cities have been injured, and one city has been so shaken that more than half of it lies in ruins. All this has happened without any warning that could have been of the least value even if it had been noticed.

I doubt even whether there was any connection whatever between the portents spoken of now, after the event, and the great earthquake which followed them. At any rate, there was no such connection as many have confidently asserted. It may be perfectly true that elsewhere great earthquakes have been preceded by abnormal conditions of weather, and especially by abnormal variations of atmospheric pressure. But it is at least as certain that such peculiarities have been again and again noticed even in earthquake or volcanic regions without being followed by any disturbance, while they are noted repeatedly in countries where, as in America but a few weeks ago, there has never been any reason to fear the occurrence of destructive earthquakes. It would be idle to assert that such indications can be regarded as earthquake warnings, though, on the other hand, I would not say that there may not be a very real connection between the earthquake and such preceding conditions of atmospheric pressure. If the subterranean tensions, no matter how produced, are very nearly balanced, as they necessarily must be before resistance against motion succumbs to gradual increase of pressure, then, no doubt, a change of pressure corresponding to an inch or two of height in the mercurial barometer might bring about the catastrophe, much as the slightest pull of a hair trigger may bring about an explosion whose force has nothing whatever to do either with the pressure on the trigger or with the force with which the hammer strikes the cap.

We may, indeed, find some little light thrown on the immediate causes of earthquakes by considering the evidence we have as to their occurrence at the time of particular states of atmospheric pressure, or in connection with the special condition of tidal waters, and the like. It seems to have been fairly made out that earthquakes follow in some degree the seasons, occurring oftener at the equinoxes than at other times, and somewhat oftener when the earth is in that part of her orbit which is nearer the sun than when she is in the other half of her orbit. Supposing this not accidental, we may consider that at such times the tidal wave runs somewhat higher, and that, as most earthquakes affect shore-lines, we may here recognize the effects of a change of pressure which, though utterly insignificant compared with the pressures at work beneath the earth's crust, may exert a very important influence (of the hair-trigger sort) when these pressures are nearly balanced. Even the effect of seemingly slight changes of atmospheric pressure cannot be wholly despised in this respect. For example, suppose the mercurial barometer to sink rapidly one inch or to rise one inch, and remain steadily for a day or two one inch above its average height, we might notice one or other change as producing particular atmospheric effects; but what would be the effect on the pressures at work beneath a region where for many years, perhaps for centuries, forces of adjustment had been at work, tensions arising here and pressures there, until at length the whole subterranean region was ready to yield to some accumulated pressure which resisting tensions were no longer able to balance? If such a region were ten miles square, a difference of the mercurial barometer by one inch would indicate a difference of atmospheric pressure amounting to no less than fifty millions of tons! It cannot be supposed that so trifling a change of pressure as this would of itself produce any noteworthy effect. But a weight of 50,000,000 tons thrown into a scale already about to descend would certainly precipitate the descent however enormously the nearly balanced weights might surpass the additional weight thus thrown in on one side.

If we remember that over the whole of the sea region around Charleston the tidal waves are always adding and taking away a weight compared with which the amount just considered may be regarded as nothing, and that when the earthquake occurred the changes thus occurring were approaching their absolute maximum for the year, we can conceive that if a change was approaching on account of the gradual overcoming of some unknown forces of resistance by equally unknown forces of attack, this change might well have been actually brought to pass by the temporary accumulation of water pressures and atmospheric pressures, or, rather, by changes in these, temporarily remarkable in character, and seeing this we may infer that such movements were already impending, when extra changes of pressure brought them about. Even in our absolute ignorance of the nature of these movements, and of the quality of the subterranean forces at work in the neighborhood, we see some light in the circumstance that changes of pressure on the outside seem to act as determining the victory for one set of forces over the other—we may see the attacking forces over the forces of resistance.

In the present case we not only see some degree of light in such evidence, but may even recognize some trace of hope. Of course, the great question which must be in all men's minds in connection with this great earthquake is this—How far can we hereafter trust to that immunity from destructive earthquakes which in the Eastern States of America had seemed so complete? All the opinions expressed by geologists respecting the cause of this last great disturbance are unimportant compared with the question whether Charleston is likely to be again visited by an earthquake of the same destructive sort. Now, if it shall appear on inquiry that the forces which have partially destroyed Charleston, and seriously shaken the Southern States, have in reality been forces which found relief in the great disturbance, and are not likely soon (by which I mean within perhaps hundreds of years) to need relief of the sort again, then it will matter little whether the earthquake was brought about by a great land-slide beneath the sea, as some have suggested, or by imprisoned and superheated steam, as others have surmised, or (as is perhaps more probable than either view) by the accumulated effect of strains and tensions resulting from the steady process of contraction which the earth's crust is all the time undergoing. We may, even in this case, recognize in the long immunity which the United States have enjoyed from destructive earthquakes, the evidence of future safety, seeing that one great disturbance seems to have sufficed to work off the accumulated subterranean tensions of many centuries; and as long a time of comparative quiescence may be expected to follow the present earthquake as we know preceded it.

It appears to me that, viewing the matter in this way, we may confidently shake off the fears which some have been disposed to suggest in regard to the future safety of the South-eastern States, and of South Carolina in particular. Consider the case of the great earthquake at Lisbon, which resembled, in many particulars, the earthquake of August 31 last. In that earthquake, one hundred and thirty-one years ago, the whole of the Spanish peninsula was shaken; the disturbance was strongly felt in France and Italy; the Scottish lakes were so shaken that in many cases a wave traveled from end to end of a sheet of water several miles in length; and even the northern parts of the Scandinavian peninsula responded to the shock. Seawards, the disturbance spread so that half the island of Madeira was laid waste; but far beyond that, even in America, the effects of the great earthquake were felt by the then British colonists of New England and Virginia. The same fears were excited then in Europe which have been suggested quite naturally here. But for those fears, in 1755, there were more serious reasons.

Spain and Portugal had before been shaken by great and destructive earthquakes; not far off, as distance is measured in such cases as these, were the great volcanic outlets, Vesuvius and Etna, to say nothing of the ever-active Stromboli, the Lipari Isles, and the rest of the Italian volcanic region. Beyond that again lay the volcanoes of the Greek Archipelago and the active earthquake region of Asia Minor. Lisbon had stood facing the sea on the advanced front of the great land bastion, within which these regions of disturbance had so often been actively at work, while around it the sea forces, ever active in destruction, were ever busy, and not far off on this side were groups of volcanic islands, including the still active Teneriffe, surpassing even Etna in volcanic might. Can we wonder if, for many years, the inhabitants of Lisbon felt that at any moment the city might be destroyed as before—nay, might be even ingulfed, as had seemed threatened during those terrible eight minutes, in the course of which no fewer than fifty thousand persons had perished?

Yet more than a century and a quarter have passed and Lisbon has not again been visited by a destructive earthquake. Six generations of men have lived and died unscathed by subterranean shocks. If this has happened in a place manifestly exposed to earthquake dangers, at the very outskirts, if one ought not rather to say in the very midst, of an earthquake region, I cannot see why we may not fairly expect a similar immunity for Charleston—nay, an immunity probably much longer lasting than that of Lisbon has yet been, or even than it can be expected to be. It does not seem to me that the continued signs of disturbance in and around Charleston affect this probability. Past experience has shown that no great earthquake completes its work in a single shock. The downfall of a rock mass on the shore of the Amazons is always followed by a succession of falls along both banks of the great river, and both above and below the scene of the first fall, until it seems as though a battle between the Gods and the Titans were in progress (so did the eminent traveler, Bates, recently describe these phenomena on the Amazons, as he calls that aggregation of rivers). In like manner, but on a much grander scale, is it when, in the subterranean contest, ever at work, some great accumulation of pressures finally overcomes the stalwart resistance which had been long opposed to it. The shock following that first great subterranean disturbance is followed by others, and these again by others, before the subterranean equilibrium is finally restored. But, after that condition of equilibrium has been brought about, there is nothing to prevent the state of rest thus reached from lasting for centuries. And, so far as one can judge from all past experience, there is even stronger reason for supposing that this will happen in the case of Charleston than in the case of Lisbon or Antioch, or other cities which, in past times, have been destroyed by earthquakes. For in their case there had been before, and there have been since, the clearest signs of constant subterranean disturbance near and around them. In the case of Charleston there has long been in the past, and we may well hope that there will long be in the future, signs as clear and marked of relative stability.

In conclusion, I would venture to offer a remark on the statement which has recently been made and widely repeated, that earthquakes are increasing in number. It might not be sufficient to assert, what, however, is certainly the case, that all antecedent probabilities are against the truth of this idea. For *à priori* probabilities must always give way before observed facts. But what in this case is the observed fact? Simply that the number of recorded earth-throes has increased in a greater degree than could be expected from the mere increase in the attention directed to earthquakes. At first sight nothing seems clearer than that this has happened, and nothing can seem more certain than that such evidence is decisive. But in reality the evidence which has been gathered has not the meaning which has been (very naturally) attributed to it. It is not the case that observed earthquakes of a certain kind have increased four or five times in number. Were it so we might well say that such an increase could not be explained by mere increase in the number of observers. What has happened has been this, that observation has so far increased in exactness that earth-throes, such as before had been left unnoticed, are now observed and recorded. This is a very different matter. If we extend our observations so as to include an entirely new class of earthquakes, we may increase in any degree whatever (what degree can only be determined by observation) the number of recorded earthquakes. There may be a thousand tremors to every throe, a hundred earth-throes to every earthquake, properly so-called.

RICHARD A. PROCTOR.

II.

SEND BACK THE OBELISK!

ON a cold, disagreeable day in the mid-winter of 1881 I was present in the fashionable throng gathered in the Metropolitan Museum of Art to witness the dedication to the city of New York of Cleopatra's Needle, which had been transferred from Egypt and erected at the door of the museum in Central Park.

It was with a feeling of sadness akin to pain that I looked upon the familiar form of my old friend, for such, indeed, the obelisk was. During my long military service in Egypt I had frequently encamped within the limits of its shadows, and, when lost in day-dreams, I had gazed upon its stony face and, musing, read there the story of its past grandeur and glory. In imagination I saw it as it stood at the door of the great Temple of the Sun at Heliopolis, where it reflected from its gold-embellished sides the lights which flashed from the altars within, kindled by the hand of the great high-priest who performed the sacred rites, him who was the father-in-law of Joseph. There, side by side with its fellow monolith, it stood, and, wet with the dews of morning, waited to be kissed by the rays of the sun, or turned its face southward and along the Nile, as if to salute its sister obelisk in the far distant Ethiopia at Karnac.

Again, I saw it at Heliopolis at the period when Herodotus and Plato were there engaged in studying the "Wisdom of Egypt." And again I saw it standing in the Sebasteum, at Alexandria, where it had been removed by the loving hand of Cleopatra. And thus I saw it loom out from the blaze of fire and cloud of smoke as the grand temple fell under the infamous decree of the Emperor Theodosius.